

DOI:

Zhen Zhang. Review and prospect of the development of harmonic energy metering technology [J].\*\*\*\*, \*\*\*\*, \*\*, (\*\*): 00-00

# Review and prospect of the development of harmonic energy metering technology

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**Abstract:** This paper mainly introduces the development and application of harmonic power metering technology in China since the 21st century. With the increasing demand for harmonic power metering in the power grid, the introduction of the world's first harmonic power definition standard, IEEE 1459- -2000, has promoted the development of harmonic power metering technology. The text also mentions the elements of the application and development of harmonic energy metering technology, including the expansion of the scope of harmonic pollution in the power grid, the confusion of harmonic energy metering instrument adopted by different users, and the new type of harmonic energy metering technology introduced in the world. In addition, this paper also introduces the domestic independent development of harmonic energy measurement technology, such as 0.2S level three-phase electricity meter, 0.2S three-phase harmonic active energy metering series products, three phase wave active energy metering products, and using the Hilbert digital filter and low frequency filter calculation harmonic reactive power metering chip development of cutting-edge practical technology. In general, this paper summarizes the development process, application status and future development direction of harmonic power measurement technology in China, as well as the related technology and product achievements.

**Keyword:** Harmonic metering power system

Chinese chart classification number: TM933.4

## 0 Introduction

Since the 21st century, the harmonic power measurement technology in China is developing rapidly, and the definition of harmonic power has shifted from theoretical controversy to practical discussion. With the introduction of harmonic reactive electric energy metering chip and harmonic / fundamental wave active electric energy metering chip, and the trial of imported and domestic three-phase harmonic wave meter and three-phase basic wave meter into the network, the electric energy measurement technology has realized a major leap from sinusoidal wave measurement to non-sinusoidal wave measurement.

Promote the application and development of harmonic electric energy metering technology

- Harmonic pollution of the power grid is becoming increasingly serious, and the pollution scope is expanding. Not only the traditional smelting enterprises, electrified railway, the use of high power rectification equipment industry, its power quality problems are very prominent; and with small rectification equipment, computers, color TV, frequency conversion appliances and other medium and small power capacity enterprises, urban residential electricity community, its current harmonic often more than 50%. Therefore, different users use the principle of harmonic electric energy metering instrument, become a puzzle.

- The world's first harmonic power definition standard IEEE 1459- - 2000 was introduced. Harmonic power theory includes the controversy of definition and attribute. After several decades, the new theory is not perfect and causes a new controversy. IEEE1459- - 2000 is a summary of the theoretical disputes in history, and to meet the needs of the application and development of harmonic electric energy metering technology.

- Introducing new international harmonic power metering technology: harmonic power metering standard, online harmonic power meter, high-performance integrated circuit, etc.

- Harmonic electric power metering and

traceability. In recent years, the imported high accuracy standard table and the measurement technology institutions of many countries can provide the harmonic active power and harmonic optic power detection report.

- Adapt to the new ideas of power grid to expand power marketing. How to use the existing power billing policy, using the new harmonic power metering technology to improve the power marketing, but also for the formulation of the economic policy to restrain the harmonic load.

This paper will summarize the introduction of harmonic electric energy measurement technology, the results of domestic independent development, the trial of the network, and make some explanations to the development of the frontier practical technology of harmonic electric energy measurement.

## 1, the introduction of harmonic energy metering technology, domestic independent development achievements

As the initial stage, the introduction of harmonic electric energy metering technology and domestic independent development are the basic means and technical forerunner to explore and understand the distribution and characteristics of electric power harmonic load, and the accumulation of measurement data.

### 1) Harmonic active and electric energy metering

- 0.2S level three-phase watt-hour meter (imported): with harmonic, fundamental active energy metering function, sampling rate 256 points / wave, internal using modular structure, A variety of modules according to different logic, namely using A / D sampling measurement module, FFT module, harmonic power calculation module, integral module, realize the fundamental and 2-63 harmonic harmonic energy metering function.

- 0.2S class three-phase harmonic active power metering series products (domestic):

- Sampling rate of 256 points / weekly wave, using the FFT transformation technique

- The first application mode: 0.2S level three-phase harmonic active power meter based on the

principle of digital multiplier, with the function of harmonic analysis, providing harmonic active power and harmonic active power power current direction

- The second application mode: the 0.5S level three-phase base wave active energy meter based on the sine wave power theory

- The third application mode: the total active electric energy is calculated by using the sum of the absolute value of the base wave electric energy and the harmonic electric energy, with the function of harmonic analysis, and provides the harmonic active power and the power flow direction of the harmonic active power

- Measure the amplitude and initial phase of the voltage and current harmonics 2- -49 times. Specifically, the amplitude accuracy of 2-21 harmonics is 2% and the initial phase accuracy is 2°.

- -0.2S class three-phase base wave active electric energy metering products (imported products)

- Harmonic suppression ability: 3 harmonics are better than 30dB; 5 harmonics are better than 60dB; 7 harmonics are better than 90dB

- Measure the harmonic voltage of 50 times, current amplitude, initial phase and power

- Measure the active electric energy of the forward, reverse and four quadrant fundamental waves of the divided phase and three phases, and the maximum demand of the fundamental wave.

- -Three-phase harmonic / fundamental wave active electric energy metering chip

- Load dynamic range: 1000:1, active power linearity of 0.1%

- Use bandpass filter to realize the separation of base wave component and harmonic component: when measuring the base wave electric energy, use low pass filter, and the attenuation rate of harmonic more than 3 times- -30dB; when measuring harmonic electric energy, use the base wave repressor and the base wave attenuation rate- -30dB.

## 2) Harmonic reactive electric energy metering

- -Three-phase harmonic reactive power measurement method using Hilbert digital filter (patented technology)

- Type IIR Hilbert digital filter designed by a

half-band filter

- In the design frequency range of 40- -960Hz, all the same time voltage and current harmonic waves are shifted by 90°, and the maximum phase error is not greater than 0.025°

- From the sum of the direct metering base wave and the reactive power of each subharmonic, the relative error with the simulation results is 0.020%

- The measurement method has the advantages of lower order and less computation and data storage

Note: Domestic harmonic reactive electric energy metering chip has been designed and produced using Hilbert digital filter

- -Metering chip using low frequency filter to calculate harmonic reactive power (imported products)

- In the voltage and current circuit, add a unipolar low frequency filter, whose cutoff frequency is 2Hz, far lower than the base wave frequency, it makes the base wave and each harmonic phase shift 90°, followed by 20dB decade attenuation: through the calculation of the signal cycle, complete the gain attenuation of the following frequency for dynamic compensation, to realize the harmonic reactive power measurement

- Test: the voltage circuit adds 10%, the current circuit adds 20% three harmonics, the initial phase is 30°, the harmonic reactive power measured by the low frequency filter, the error between the harmonic reactive power defined by the IEEE standard is 1%. The chip has the effect of near-Hilbert conversion.

- -0.2S class three-phase base wave reactive meter (imported products)

- Metered forward, reverse and four-quadrant base wave reactive electric energy of phase and three-phase

- Harmonic suppression ability, metering harmonic voltage and current function, are the same as the above 0.2S class three-phase base wave active power meter (imported products).

## 3) Harmonic vision in the electric energy metering

0.2S-class low-cost metering three-phase multifunctional meter (imported products)

- The active electric energy metering is 0.2S, and

the accuracy of the dependent power and electric energy metering is 2%

- Visual power uses two different algorithms

- First type: vector algorithm

The vector  $VA = (\text{active power}^2 + \text{reactive power}^2)^{0.5}$

- The second type: the arithmetic algorithm

Arithmetic  $VA = U_{rms} I_{rms}$

If a harmonic current is present, the harmonic voltage is zero:

Vector VA, containing no harmonic effects

Arithmetic VA, including the harmonic effects

Arithmetic VA, always greater than or equal to the vector VA

- Power factor calculation

- Power factor is equal to the active power / apparent power

- Power factor using vector VA, without harmonic influence

- Power factor using arithmetic VA, including harmonic effects

- The power factor calculated using arithmetic VA is always less than or equal to the power factor calculated from the vector VA.

#### 4) Harmonic electric energy metering standard

— Europe

Level 0.01 three-phase standard watt-hour meter: with harmonic active and reactive power, apparent power measurement function, base wave measurement 15- - 70Hz, harmonic measurement to 3500Hz. By the internationally recognized measurement technology institutions verification: the standard table base wave, 2- - 9 harmonic voltage, current harmonic content of 30%, 11- - 40 harmonic voltage, current harmonic content of 5% active, the total uncertainty of the apparent power is 90- - 15010- - 6.

— America

- Automatic calibration system of electric energy meter: under the total content of 30%, the accuracy of electric energy measurement is  $\pm 0.005\%$  -  $0.05\%$

- Power power standard source: provide 7 optional methods to calculate the reactive power of non-sinusoid wave signal. The fundamental wave frequency measurement range is 16- - 850Hz, the

maximum harmonic frequency is 6 kHz, and the output is 100 harmonics. The addition of harmonics will not significantly weaken the measurement accuracy or traceability.

The introduction of the above harmonic electric energy measurement technology and the domestic independent development results are suitable for the steady-state and continuous integer harmonic electric energy measurement.

Internationally, the harmonic active and apparent power metering technology has been completed from online metering products to metering traceability, but the harmonic active and apparent power metering standards have not undergone international comparison; the traceability of harmonic reactive power metering needs to be checked.

In China, the design and development of online harmonic active and reactive power measurement technology is very characteristic; the online electric power measurement technology, the design and development has not been started; the harmonic electric power measurement standard is still blank, which has affected the application and development of domestic harmonic electric energy measurement technology.

## 2. Application of harmonic electric energy metering technology

In recent years, domestic journals have published the practical calculation of power in non-sinusoidal and three-phase asymmetry system, analysis of the definition of reactive power in non-sinusoidal cases, the influence of impact load on electric energy metering, electric power Sampling and Measurement technology and its development overview, which provide guidance for the development of harmonic electric energy metering technology, and promote the trial of harmonic electric energy metering products: since 2002, harmonic reactive electric energy metering became a technical hotspot; in 2003, harmonic active electric energy metering technology trial; in 2005, harmonic vision in electric energy metering products into the power market. After years of operation, has accumulated preliminary application experience and

adjust the idea of measurement product structure.

### 1) Application of harmonic reactive electric energy metering technology

- Problems arising in the application of the traditional reactive electric energy metering method:

· Adopt electronic sinusoidal reactive electric energy meter measurement

A 1 Base wave reactive power calculation formula:

$$Q_1 = V_1 \times I_1 \times \sin\theta$$

Cal formula of harmonic reactive power defined by a2 IEEE1459- - 2000 standard: (omitted)

A 3 electronic sinusoidal reactive meter adopts voltage base wave delay 1 / 4 base wave period, and its harmonic reactive power calculation formula: (omitted)

From the analysis of the above formula, the harmonic frequency is  $5, 9, 13 \dots 4K + 1$  and other odd harmonic phase shift  $90^\circ$ , adding the reactive power of these odd harmonic, the harmonic reactive power measurement is correct (note: K is an integer of zero or greater than zero). The harmonic times are  $2, 6, 10 \dots 4K + 2$  even harmonic phase shift  $180^\circ$ ;  $3, 7, 11 \dots 4K + 3$ ;  $4, 8, 12 \dots 4K + 4$ , the reactive power measurement of these harmonics is incorrect, the maximum absolute error is 2 times the power.

After testing: add 10% of the voltage circuit and 20% of the current circuit, the voltage and current harmonic initial phase are  $30^\circ$ , the harmonic reactive power measured by the sinusoidal base wave cycle, the error between the harmonic reactive power defined by IEEE standard is 4%.

Therefore, it is not reasonable to adopt the electronic sinusoidal reactive meter under non-sinusoids.

Note: Domestic three-phase standard table mostly adopts the measurement principle of voltage base wave delay 1 / 4 base wave cycle.

· Reactive power measurement method calculated according to the power triangle

In the presence of harmonics, additional errors are generated. After testing: adding 10% on the voltage circuit and 20% on the current circuit, the voltage and current harmonic initial phase are  $30^\circ$ , and

the error between the harmonic reactive power calculated by the power triangle and the harmonic reactive power stipulated by IEEE standard is 1.9%.

· Cosine induction reactive meter is used to calculate harmonic reactive power, with the maximum absolute error of 3 times ( $60^\circ$  wiring) and 2 times ( $90^\circ$  wiring) harmonic apparent power.

· Three electronic single-phase active power meters are adopted to measure harmonic reactive electric energy according to the cross-phase  $90^\circ$  wiring, and the measurement accuracy needs to be further verified.

- Using Hilbert digital filter or low frequency digital filter to measure harmonic reactive power energy method, due to the lack of harmonic reactive power measurement standard, its measurement accuracy can not be calibrated or compared temporarily.

- Harmonic reactive electric energy meter can only measure the base wave reactive electric energy and the voltage and current of the same harmonic reactive electric power, so its use range is limited. There are estimated to be four million three-phase reactive power metering points nationwide, including user metering for power factor billing, distribution transformers and reactive power energy metering for substations. In most cases, the voltage is basically sinusoidal, and the harmonic current content exceeds the standard.

### 2) Application of harmonic active power and electric energy metering technology

- Trial situation of three-phase harmonic / fundamental wave active power meter: It is estimated that there are 7 million metering points of various three-phase active electric energy nationwide. Since 2003, Hunan, Shandong, northeast and other power systems have tried the three-phase harmonic active power meter / base wave active power meter about 1500 sets. After several years of operation, the reading of the harmonic / fundamental active meter is not very different from the traditional three-phase active meter, and some measurement data are the opposite as expected. The reason for the preliminary estimate is that the voltage harmonic content on the metering

point is not large, or the harmonic active power power flow discrimination is not correct.

- -Harmonic active power current analysis method: After summarizing domestic journals and data, there are mainly three analysis methods:

· The first analytical method

A 1 The base wave power emitted by the generator is converted from a part of the base wave electric energy into the harmonic electric energy by the harmonic source user

A 2 harmonic source users send harmonic electricity, which pollutes the power grid and reduces the electricity cost.

A 3 anharmonic source users reluctantly absorb harmonic electricity to increase the electricity bill.

A 4 generator: harmonic power will reduce the economic benefits of the power grid and affect the safe production.

· The second analytical method

A 1 According to the law of conservation of energy, the harmonic energy and fundamental wave energy come from the power source, and the total energy is the sum of the two.

A 2 The measurement error of the electricity meter caused by the harmonic active power is basically negative. This view is not comprehensive. The size of the measurement error is related to the harmonic content, the initial phase of the secondary wave and the base wave. The influence of harmonic active power flow on the electric energy measurement needs to be further verified.

· The third analysis method

A 1 Nonlinear load can be understood as a harmonic source, which converts a part of the sinusoidal power into harmonic power, which is fed back to the grid as grid waste, and it is deducted from the energy metering.

A 2 The harmonic electric energy calculated on the electric energy metering point is negative, and the electric energy loss of electric energy by the harmonic current in the line impedance is positive. As an expedient measure, the base wave active meter is used for such users.

· To promote the application and development of

harmonic active power metering technology, continue the base wave meter or harmonic meter, with blindness: urgent to unified active power tide analysis method, design and production of harmonic active power tide analyzer, provide base wave power, forward and reverse harmonic active power and its harmonic frequency, the harmonic amplitude, initial phase. How to calculate the total active power energy is defined by the power system and the user according to the metering data. After years of measurement data accumulation, we can put forward the discrimination of the harmonic active power current direction and the total active power electric energy measurement method of different types of enterprises in different situations.

- -Similar to the harmonic reactive meter, the harmonic active meter can only measure the active electric energy of the base wave and the harmonic electric energy with the same voltage and current, so it also limits its use range. It is estimated that there are 600,000 large users with 315 kVA and above, and less than large enterprises with excessive voltage and current harmonic content is 5%. However, the electricity consumption of these large users is huge, and the fluctuation of active power energy is estimated to be billions of kWh every year. Therefore, it is of great practical significance to study and develop the active power measurement of dynamic harmonic load and shock load

### 3) Application of harmonic vision in electric energy metering technology

- -IEEE1459- -2000 standard stipulates that the harmonic apparent power of the arithmetic algorithm is used to calculate the harmonic power factor. Its calculation formula:

$$PF=P/S=P/V \times I$$

Where: P- -harmonic active power

S- -harmonic vision at power,  $S = VI$

- -Users with 100 kVA or above will implement the Measures for Adjusting Power Factor and Electricity charges, which is estimated to be 3 million households nationwide. Among them, 95% of users only have excessive content of current harmonics. Taking the power distortion load formed by computer

batch application as an example, the power factor measured by sinusoidal reactive meter is close to 1.0; the power factor calculated by arithmetic algorithm is only 0.6. The two power factor algorithms are very different.

-According to the Adjustment Method of Power Factor Electricity Charge, according to the rated power factor of 0.9 (large user) and 0.85 (medium capacity): the actual power factor of the user is higher than the rated power factor will be rewarded, and the electricity cost will be reduced; that lower than the amount of the rated power factor will increase the electricity charge. From a power factor of 1 to 0.65 or below, users' electricity bills fluctuate by 15%. It can be seen that the power factor calculated by the dependent power of the arithmetic algorithm not only conforms to the actual situation of the power load, but also improves the operation and management of the power grid.

#### **4) The harmonic metering technology of urban residential electricity consumption remains to be developed**

- -According to the sampling test: home computer, color TV, color display power supply, the voltage harmonic content is 6%, 3 harmonic current content 50%, 9 harmonic content 30%, 17 harmonic content 8%. It can be seen that the characteristics of urban residents electricity, also the current harmonic content seriously exceeds the standard.

- -At present, there is only active electric energy metering method for residential electricity charging, etc. The electronic active power meter with high enough sampling rate should be selected to measure harmonic active electric energy.

- -In order to restrain the rapid growth of harmonic current, it is necessary to develop a simple online harmonic metering instrument adapted to the characteristics of electricity consumption of urban residents. Its main metering functions:

- Total content of voltage and harmonic wave
- Total content of current harmonics
- Harmonic pollution degree = non-fundamental

wave view at power / fundamental wave view at power

- -In addition, the power system and electricity meter industry should take the initiative to report and communicate with the price authorities, and suggest that residential electricity is gradually charged according to the apparent electricity energy, which is conducive to reducing the harmonic content of household appliances, saving energy and purifying the electromagnetic environment. At the same time, the feasibility study of single-phase and three-phase visual in the electricity meter product design should be carried out.

Summing up the above experience of network trial, is how harmonic power metering technology and products enter the power market, is mainly close to the actual power load, to meet the needs of power marketing and management improvement. At present, some basic problems of harmonic active power measurement are controversial, the standard technology of harmonic reactive power measurement is being explored, only harmonic vision in electric energy measurement and harmonic power factor calculation may become the entry point to enter the power market. Also, the harmonic measurement of urban residential electricity, should be mentioned on the agenda.

### **3. Development of frontier practical technology for harmonic electric energy metering**

At the user end of the power grid, the composition of the actual power load is not only a steady-state, continuous integer harmonic load, but also the specific situation is much more complex. For example, the fluctuation of the voltage of the power grid, the fluctuation frequency is 1-15Hz, three harmonic current content is above 30%, the maximum negative order current is 86%, the minimum power factor is 0.1; large capacity ac-ac frequency synchronous motor, 18%, the harmonic and harmonic 0.3, 3.7, 9.7 current harmonic content are more than 2%, 23, 25 harmonic current, these load complex situation, need to solve. In this regard, some frontier practical topics of harmonic electric energy metering have been put forward in China in recent years, and preliminary

results have been obtained in theoretical research:

1) Theory and algorithm of impact load electric energy metering

- Apply the generalized power theory to define the power of the single-phase and three-phase circuits of arbitrary waveforms

- The sinusoidal circuit power theory, traditional non-sinusoidal circuit power theory and generalized power theory are applied to calculate the active power, reactive power, dependent power, distortion power and three-phase asymmetric power power of impact load.

2) Using wavelet transform harmonic and active and reactive electric energy measurement method

- Wavelet transform has good time- - frequency characteristics, and the harmonic analysis method of multiphase IIR Butterworth wavelet filter set is used to solve the qualitative and quantitative analysis problems of unstable harmonics.

- After the power measurement of simulated signal and actual signal, the accuracy of active power and reactive power measurement with the multiphase filter set of wavelet transform is in the order of  $10^{-5}$ .

3) Short-time FFT transformation is used for interharmonic measurement

- Measure the effective value, phase and harmonic content of 0- - 2500Hz intervoltage harmonic; the effective value, phase, harmonic content and direction of 0- - 2500Hz intercurrent harmonic.

- Phase accuracy of base wave:  $\pm 0.5^\circ$ , measuring range: 0- -  $360^\circ$ .

4) Fractional harmonic analysis method

A new harmonic analysis method of window function is constructed from the time domain: through simulation experiment, the amplitude relative error of strong harmonic signal is  $10^{-4}$  order of magnitude, the absolute phase error is better than  $0.003^\circ$ ; the amplitude relative error of weak harmonic signal is 3.4%, and the absolute phase error is  $2.4^\circ$ , which is far better than the current window interpolation harmonic analysis algorithm.

5) Related articles also published in domestic journals include: "Measure Power Factor with Wavelet Transform", "Non-integer Harmonic Measurement

Method based on continuous wavelet Transform" and so on.

These above practical topics of harmonic electric energy measurement not only use the traditional FFT, short-time FFT transformation and its improvement algorithm, but also introduce the generalized power theory, wavelet transformation and other new technologies to solve these complex measurement problems. These cutting-edge practical measurement topics need follow-up research and development, and transform the preliminary results of theoretical research into online measurement products, testing instruments or measurement standard equipment.

#### 4. Summary language

Domestic harmonic electric energy metering technology after just a few years of network trial, has achieved preliminary results, which is to explore the application and development of harmonic electric energy metering technology, see the difference and gap with similar metering product technology in the world. next step, To deepen the design and improvement of harmonic measurement products, In preparation for expanding the trial period, The prerequisite is that the domestic to launch reliable quality, power applicable harmonic active power, reactive power, depending on the electric energy metering series products, And can be carried out metering traceability: focus on the harmonic vision in electric power and harmonic power factor practical product design, Harmonic active power power current analysis technology, Electric energy metering technology of dynamic harmonic load and shock load, Improve and improve the dynamic characteristics of AC sampling power measurement method; For the harmonic reactive power, To thoroughly investigate the effects of harmonics on reactive electricity meters, Explore the transition measure of harmonic reactive power measurement accuracy verification; Harmonic electric energy metering standard construction, Comprehensively strengthen the independent design and development of measurement standards, The introduction of domestic shortage, urgent need of international advanced measurement standard



equipment. As the first step, the working standard of harmonic power metering is introduced to meet the needs of the application and development of harmonic electric energy metering technology. At the same time, it is necessary to investigate the harmonic distribution of the power system, estimate the market capacity, clarify the application and development goals of harmonic energy metering technology, and do well the application and development planning, including the planning of the frontier practical topics of harmonic energy metering.

Finally, it should be pointed out that the trial of harmonic electric energy metering into the network is only the initial stage, and then expand the trial, promotion and application, to fully complete the transformation from sinusoidal metering to non-sinusoidal electric energy metering technology, which represents the development trend of electric energy metering technology, but the whole process is long. When it comes to the prospect of market expansion, it is expected that harmonic vision will be applied in electric energy measurement and harmonic power factor calculation technology, and the application of harmonic active and reactive electric energy measurement technology will be gradually made clear after expanding the trial.

After 2005, the research results of the key development of harmonic electric energy measurement technology:

1. In June 2006, Scholar of Tsinghua University: Harmonic reactive Power Measurement Method based on 2 pairs of Hilbert Phase Shift Filters

2. In September 2007, China Metrology Institute: Research on Power Frequency Harmonic Power Standard"

- -October 2008, China Metrology Institute: Cyclic Signal Sampling and Measurement Strategy

3. In 2010, Weisheng Group Company launched China's first DTSD 341- - -9 ZV 1.0 high-precision impact load three-phase multi-functional electricity meter

4. In April 2010, the former Henan Star High-tech Co., Ltd.: ST 1000 0.01 Level three-phase

Standard Electricity Meter pointed out that "distortion wave can be decomposed into a series of algebraic sum of sinusoidal vectors, so the active power and reactive power algorithm of distortion wave are the algebraic sum of each harmonic power algorithm"."The computational accuracy of Fourier algorithm depends on the integration accuracy of digital discrete sequence. Since ST 1000 adopts asynchronous sampling with fixed sampling frequency, all the simplified integration formula of full cycle sampling is no longer applicable, and a new algorithm needs to be adopted to improve the integration accuracy of asynchronous sampling."

5. In March 2011, Zhejiang Metrology Institute and China Metrology Institute: Experimental Research on the Dynamic Characteristics of Electricity Meters

6. Tsinghua University Scholar, Panzhihua Iron and Steel Company:

Testing and Research on the Effect of Harmonic Phase on Network Access Harmonics

7, the international, harmonic power measurement new technology reference

1) In 2010, IEEE1459- - -2010 standard was introduced to replace IEEE1459- - -2000 standard.

**2) Around 2012, GE launched the KV2c <sup>TM</sup> three-phase multi-function electricity meter, which has the function of distortion power and harmonic power factor calculation.**

Expectations for 2018

As can be seen from the previous description: from 2002 to 2010, the application and development of harmonic electric energy metering technology in China has been a high heat, mainly manifested in:

· Strong electricity meter enterprises cooperate with provincial power grids to develop impact load / harmonic load active power meters, and put them into the network for trial.

· Colleges and universities focus on harmonic reactive power metering schemes, algorithms and simulation technologies, and often publish articles in domestic / international journals.

· An electric meter enterprise introduced and sold an electronic three-phase electric energy meter with harmonic vision power and arithmetic algorithm to

calculate power factor.

However, after 2010, the application and development of harmonic electric energy metering technology was restricted and cooled down. Analyze the main factors:

- The focus of state grid metering work has been shifted to promoting the application of smart electricity meters and the construction of electricity information collection system, which is a massive metering project supporting the development of smart distribution network.

- State Grid implements unified planning and whole-process management for key metrology science and technology projects, including development fund management. Most provincial power grid metering centers are difficult to declare or allocate to key metering science and technology projects.

- Many years ago, the measurement experts of the Institute reported the harmonic pollution of the power grid, but did not reply; so far, the price authorities has not introduced economic measures to restrain the harmonic pollution of the power grid.

, Its smart watt-hour meter enterprise standard of metering function, mainly according to the needs of the current electricity price policy design, rarely reaction grid more professional application and power grid comprehensive development of measurement

function, including grid line loss calculation, power grid distributed reactive power balance, intelligent distribution network power quality monitoring, promote the economic measures of suppress harmonic load growth.

2018 may be a turning point year for science and technology measurement work. In 2017, State Grid realized the full coverage of the application of smart electricity meters and electricity information collection system. At the beginning of 2018, the State Grid Metrology Promotion Meeting will arrange the key metering new technology development and metering management projects throughout the year, expecting to put forward new demands for the development and application of harmonic power metering technology, and integrate into the new journey of high-quality intelligent distribution network construction.

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